May 1, 2018

Ms. Marlene H. Dortch
Secretary
Federal Communications Commission
445 12th Street, S.W.
Washington, DC 20554

Re: **Oral *Ex Parte* presentation in RM-11681 "Petition [by Ligado Networks] for Rulemaking to Allocate the 1675-1680 MHz Band for Terrestrial Mobile Use"; IB Docket No. 12-340 "LightSquared Request to Modify Its ATC Authorization."; IB Docket No. 11-109, Regarding the Ligado Modification Applications; GN Docket No. 17-183 Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz Notice of Inquiry.**

Dear Ms. Dortch:

On April 26, 2018, the following representatives from industry, organizations and academia of the weather, meteorological satellite and satellite ground systems communities met with Will Adams, Legal Advisor to Commissioner Brendan Carr:

- Mr. Brett H. Betsill, Radio Frequency Equipment Design Engineer and Ground Station Manufacturer, President, Microcom Design, Inc., Hunt Valley, Maryland
- Ms. Janice Bunting, Executive Director, National Weather Association (NWA), Norman, Oklahoma
- Dr. Jordan Gerth, Associate Researcher, Space Studies and Engineering Center (SSEC), University of Wisconsin, Madison, Wisconsin
- Colonel Michael Jamilkowski, USAF, (Ret.), Fellow of the American Meteorological Society (AMS), Silver Spring, Maryland
- Ms. Renée A. Leduc Clarke, Founder and Principal, Narayan Strategy, a weather and climate policy consulting firm, Washington, D.C.

The primary purpose of this meeting was to present information on how real-time water and weather information received directly from the Geostationary Operational Environmental Satellite (GOES) satellite in 1675-1695 MHz is used by the hydrometeorological, transportation and wildfire management communities and to discuss concerns regarding proposals to share 1675-1680 MHz with strong terrestrial transmitters proposed by Ligado Networks.

AMS, NWA, Microcom Design, Narayan Strategy and the University of Wisconsin's SSEC, in addition to representatives of Aviation Spectrum Resources, Inc. (as a member of the Joint Aviation

Parties)[1], AccuWeather[2], the American Weather and Climate Industry Association (AWCIA)[3] and the Harris County (TX) Flood Control District[4] who were unable to attend the current briefing in person, have filed multiple letters in the RM-11681, 12-340 and GN 17-183 proceedings, and references to these letters were mentioned by the participants in this briefing. For example, participants referenced how science data and imagery from GOES (and the currently deployed or deploying GOES-R series) satellites are used by Federal and non-Federal meteorologists, hydrologists and emergency managers to protect life and property across the U.S. and its territories and support the economy.

It was noted that the National Oceanic and Atmospheric Administration (NOAA) and its broad community of users have already shown commitment to freeing up spectrum for diverse uses in the past few years[5]. **The design of NOAA's new GOES-R series of satellites was changed in 2011 to move out of AWS-3 spectrum in 1695-1710 MHz pushing it below 1680 MHz, placing low powered satellite downlinks in close proximity to strong terrestrial services, while effectively constricting the amount of bandwidth available to future GOES satellites.** Although the GOES-R series will produce exponentially more real-time data than current generation GOES systems on orbit, additional spectrum sharing in this band would handicap users desiring to obtain GOES-R data. In addition to a recent move involving the redesign of National Weather Service (NWS) radiosondes, this proposed action would be a third major impact in recent years on the hydrological and meteorological forecasting communities due to spectrum changes.

NOAA's GOES Satellites and their Reliance on Spectrum

GOES-R series satellites, which include GOES-16 and GOES-17 that both launched in the past 18 months, have a rebroadcast system (GRB) that produces a steady stream of data at a rate of 31 mbps. This only represents one of several downlinks in the entire band.

Timeliness and quality are crucial to this type of information, which is relied upon for second-by-second severe weather forecasting, volcano eruption tracking for aircraft, hot spot monitoring in high fire risk areas and other environmental applications where seconds matter. As noted in past *Ex*

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[1] August 12, 2016 Reply Comments in RM-11681 of Airlines for America, Aviation Spectrum Resources, Inc., Cargo Airlines Association, Delta Airlines, Federal Express, Helicopter Association International, National Air Transportation Association, and National Business Aviation Association ("Joint Aviation Reply Commenters") https://ecfsapi.fcc.gov/file/1081211620678/Joint%20Aviation%20Reply%20Comments%208%2011%202016.pdf

August 17, 2016 Ex Parte Presentation of Airlines for America, Aviation Spectrum Resources, Inc., Aerospace Industries Association, and Helicopter Association International in IB Docket Nos. 11-109 and 12-340 https://ecfsapi.fcc.gov/file/108171106228817/Aviation%20Spectrum%20Resources%20et%20al%20Ex%20Parte%208-17-16%20Final.pdf

[2] June 20, 2016. Comment of AccuWeather, Inc. in RM-11681 https://ecfsapi.fcc.gov/file/10620917918454/AccuWeather_FCC_Letter_6.20.2016.pdf

[3] June 20, 2016. Comment of AWCIA in RM 11-681. https://ecfsapi.fcc.gov/file/106181626322744/AWCIA%20FCC%20letter-061716.pdf

[4] June 21, 2016. Comment of Harris Co. (TX) Flood Control District in RM 11-681. https://ecfsapi.fcc.gov/file/10621162389924/HCFCD%20FCC%201675-1680MHz%20Spectrum%20Protection%20Comments_6-21-16%20final.pdf

[5] NOAA operates in 20 MHz of Federal use spectrum (1675-1695 MHz) and no longer has exclusive use to the additional 20 MHz formerly for Federal use; the AWS-3 spectrum in 1695 – 1710 MHz and the 5 MHz of spectrum (1670 – 1675 MHz) auctioned in 2002 and now leased by Ligado Networks. Yet, from GOES to GOES-R reflects about 15 times increase in data for the broadcast downlinks using this spectrum.

Parte, data transmission options that involve the cloud to deliver this information will not be sufficient to fulfill the most urgent emergency needs across the country for this information.

It is the high availability requirement of 99.988%[6], with low latency over such a broad geographic area that is a substantial factor to consider beyond the service's data rate. A non-geosynchronous orbit (GSO) communications satellite system would not always be in contact to provide data dissemination to end users; and some commercial services might not offer coverage in all the areas where it is now available. Such a rigorous data reliability standard for GOES rebroadcast services (GRB) only allows for five minutes of downtime each 30 days, and requires any outages to be resolved within five minutes. The service level agreements available through most cloud-based services typically allow for 50 minutes of downtime every 30 days, and could leave meteorological and hydrological users without data. If those 50 minutes per month happen in the midst of a major severe weather event, such a lack of real-time data to forecasters could mean the difference between a family receiving a warning of incoming severe weather (including tornadoes) with sufficient lead time, or not. Those cloud-based service level agreements often do not include the impacts from internet connectivity which carries the information from the cloud-service access point to a user's premises and reduces the overall availability. Some commercial services have minimum response times for repair, stated in minutes or hours, which add to the duration of outages.

The University of Wisconsin SSEC is tracking the timeliness and quality of data from the GOES-R series satellites both via their GRB system direct from the satellite and via the internet. It has been noted that the data direct from satellite is consistently more timely and higher quality, especially during the business day, with a difference in timeliness sometimes up to 30 seconds, which is a significant factor in weather and fire predictions when mesoscale data images arrive every 30 seconds and some specialized data must be delivered within 3 to 10 seconds.

Often spectrum is allocated with guard bands to mitigate some interference from adjacent services; yet in this case the proposed sharing is in-band, which eliminates many types of mitigation that could be available as interference reduction for compatible, adjacent band services.

Use of GOES Data by the U.S. Climate and Weather Industry

The industry partners of both AMS and NWA are a group of companies providing mission critical weather information to support the public and a broad range of industries, including aviation, rail and other transportation, shipping, energy, insurance, retail, agriculture, health care and many more. Many of these companies also provide value-added, real-time information and support to the public sector including the Commerce, Transportation, Defense and Agriculture Departments, and many state and local governments. For example, AccuWeather serves two billion weather consumers worldwide each day with its forecasts and warnings, including tens of millions of people in the U.S. who rely on their mobile applications, websites, and radio or television forecasts to receive important weather updates.

[6] April 13, 2017. Written ex parte submission of American Geophysical Union (AGU), AMS and University of Wisconsin SSEC in RM-11681; IB Docket No. 11-109; IBFS File Nos. SES-MOD-20151231-000981, SAT-MOD-20151231-00090, SAT-MOD-20151231-00091 See https://ecfsapi.fcc.gov/file/104132285323927/FCC_AMS_AGU_SSEC_Feedback_April_2017.pdf

If approved, Ligado's proposal to share 1675-1680 MHz likely will only allow for limited protection zones to be established for select Federal downlink sites. The protection zones defined for NOAA so far (for AWS-3) are likely not sufficient in size to avert interference, especially at Wallops Island, VA, which is the primary ground station for the GOES and GOES-R programs, as highlighted in previous letters and in Congressional testimony.[7] In addition, as proposed, 1675 – 1680 MHz spectrum sharing does not accommodate coordination/protection zones for all other agencies within the federal, state or local governments or for industry or academia. **Such a lack of protection zones is a significant threat to major components of the U.S. weather, water and related environmental forecasting enterprise that provide crucial information to citizens for life and safety and the economy.** When spectrum sharing of such different services occurs in the same band, appropriately sized protection zones, which would prohibit installation of commercial towers in proximity to sensitive satellite ground stations, is the only viable mitigation method.

The weather, water and climate community coordinates substantially across public, private and academic lines to maximize their collective expertise to advance weather and water forecasting and related emergency management activities across the country and the world as encouraged and supported by numerous expert studies, particularly the National Research Council[8]. **Public-private-academic partnerships have been established as crucial to enhancing warning times in advance of severe storms and crucial to coordinating information to inform accurate evacuation zones for hurricane prediction.** Without consistent and reliable access to real-time information from the GOES and GOES-R satellites and its data collection system across the weather and water enterprise, predictions may no longer keep improving as they have[9], more lives will be lost and businesses will be more seriously impacted by weather and water related hazards. Research has estimated the annual value of existing weather forecasts to households at $31.5 billion in 2006[10].

Diverse Examples Show the Breadth and Depth of Negative Impact of Sharing of 1675-1680 MHz

Transportation and Storm Evacuation:

One example of real-time use via the GOES Data Collection System (DCS), which operates at 1679.7-1680.1 MHz, that will suffer if required to use a Ligado proposed CDN is by the Florida Department of Transportation (FDOT)[11], which was also detailed in a FCC comment in June 2016[12]. The FDOT has installed Earth stations that downlink real-time wind speed data that is uplinked from anemometers installed on highway bridges, particularly those on drawbridges that lead to boundary islands on the coast of Florida. The FDOT system provides data to the public

[7] An Overview of the Budget Proposal for the National Oceanic and Atmospheric Administration for Fiscal Year 2017. Environment Subcommittee of the U.S. House of Representatives Committee on Science, Space and Technology. 114th Congress. 16 March 2016. (Hearing dialogue with Rep. Jim Bridenstine (R-OK) and Under Secretary Kathryn Sullivan (NOAA Administrator)).

[8] National Research Council, "Fair Weather: Effective Partnerships in Weather and Climate Services", 2003 https://www.nap.edu/read/10610/chapter/1

[9] National Research Council, "Weather Services For The Nation – Becoming Second to None," 2012. https://www.nap.edu/catalog/13429/weather-services-for-the-nation-becoming-second-to-none

[10] Lazo, J.K., et. al., "300 Billion Served: Sources, Perceptions, Uses, and Values of Weather Forecasts," Bulletin of the American Meteorological Society," 90 (6): 785-798.

[11] https://ops.fhwa.dot.gov/weather/best_practices/casestudies/008.pdf

[12] https://ecfsapi.fcc.gov/file/1072020498400/ligado%20reply%20comments%20160619.docx

safety community to help them decide when to close and reopen bridges and highways during severe weather events. When the GOES-16 satellite became operational in November 2017, the DCS GOES-East downlink moved to 1679.7 - 1680.1 MHz, just as hurricane season ended. Their use of Earth stations to obtain real-time data transmitted over DCS is critical for FDOT users to ensure the data can be received without the use of the internet or other public telecommunications services that are often compromised during a severe weather event such as a hurricane. Similar arguments about the importance of not relying on the internet in emergency situations were made by users of the Emergency Managers Weather Information Network (EMWIN) in comments to the FCC in June 2016[13].

This FDOT project is the first of its kind to transmit wind speed data and has so far proved successful, in particular during the 2012 hurricane season when it helped inform public safety officials in real time what the wind conditions were on the bridges in and around Jacksonville, Florida. The FDOT project has been recognized by the Federal Highway Administration as a best practice for road weather management. The FDOT has expanded their project and has installed 25 NOAA GOES DCS wind speed sensors along the Florida Keys to assist with real-time traffic management and evacuation planning in that vulnerable area, which were operational during Hurricane Irma in 2017. FDOT has just begun a new project along the Florida panhandle that will install 50 DCS sensors, which will extend the monitoring to include road surface temp, air temp, relative humidity, water level, and water velocity. Other states have expressed an interest in this project and there is potential for additional Earth station installations on a national level, wherever there is concern that commercial telecommunication services may fail during severe weather or another disaster[14].

Wildfire Monitoring and Management:

There are approximately 2,650 Remote Automatic Weather Stations (RAWS) deployed by the National Interagency Fire Center (NIFC) in Boise, Idaho, which are strategically located in fire prone areas throughout the U.S. and report their data via DCS. These stations monitor the weather and provide localized data that assists wildland fire agencies to monitor fire danger, Of these stations, about 550 are intended for rapid deployment post-incident to augment on-site forecasts in real-time. The data from all of these RAWS gets downlinked via a DCS ground terminal to the NIFC (which is managed in partnership by eight different federal agencies from the Agriculture, Commerce and Interior Departments) via DCS. The NIFC recognizes that weather data is critical to predicting fire behavior, which is important to effective fire management of all kinds (suppression, prescribed burning, wildland fire use, etc.)[15]. **The data is crucial to track winds and soil moisture conditions so that wildfire weather managers can make decisions that best protect the life of firefighters and protect lives and property.** Remote sensors relayed via GOES were also deployed to make air quality measurements at Ground Zero soon after 9-11 and after major oil spills in the Gulf of Mexico to perform air and water quality measurements.

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[13] 20 June 2016 Filing in RM-11681 from the U.S. Council of the International Association of Emergency Managers: https://ecfsapi.fcc.gov/file/10620767623947/IAEM-USA%20Comment%20to%20FCC%20on%20NWS%20spectrum%20RM11681.pdf

[14] Such roadway weather information may prove valuable to operation of autonomous vehicles, as localized road conditions become important factors for such driverless cars and trucks.

[15] NIFC https://www.nifc.gov/aboutNIFC/about_main.html

GOES-16 data have proved useful in detecting wildland fires in the Central and High Plains, especially in Oklahoma, Texas, Kansas and Colorado. In several cases, the hot spots tied with initial ignition were detected using GOES data giving the NWS the tools to notify first responders before discovery and initial dispatch via 911 calls. This capability has been credited by emergency managers for saving property, and in a few cases saving lives. Very recently, the data were used to assist first responders fighting the Rhea megafire in Dewey County, Oklahoma, 12-18 April. The attached map shows notifications the NWS provided to emergency responders fighting the fire. In another recent case, a deadly oil rig explosion in Pittsburg County, Oklahoma, was first detected on GOES data and the NWS provided the first contact with emergency officials.

Further Proceedings Related to 1675-1680 MHz Should be Halted Until Further Research is Completed

The participants in the briefing stated clearly that 1675-1680 MHz should not be shared in the short term and such sharing should not be considered further until additional research is completed, including the spectrum sharing and stakeholder usage research being conducted by NOAA, funded under the Spectrum Pipeline Act of 2015, over the next two years. **This means that any consideration of moving forward with a Notice of Proposed Rulemaking (NPRM) for the bands being considered under RM 11-681 should be halted until this study is complete and briefed to all relevant stakeholders.**

The recent launches of GOES-16 and GOES-17 are the first two U.S. geostationary environmental satellites with new technology to come on orbit in nearly 30 years. This is not the time to be considering limiting the capabilities of this technology when so many years of effort and billions of taxpayer dollars have been devoted to providing timely data to enhance forecasts that will save lives and property, and support the economy.

Sharing the 1675-1680 MHz radio spectrum poses significant risks to the nation's forecast, communication, and warning capabilities for extreme events. The potential degradation in this capability would create risks to public health and safety, private sector initiatives, and scientific advancement. Significant industry segments and members of the general public are protected from extreme weather by NOAA data and products (public and private-sector created), which utilize the 1675 – 1695 MHz spectrum and have a high likelihood of interference from the Ligado proposals in 1675 – 1680 MHz[16].

Urge Caution Related to Actions That Would Impact the NOAAPort System in Mid-Band Spectrum Between 3.7 and 24 GHz

AMS and NWA also wish to note the importance of unfettered access to the NOAAPort system, which provides important weather information to many meteorological data users in the public, private and academic sectors for whom the nation relies on for critical weather forecasts, watches

[16] Ligado indicates they would supply data to trains, helicopters, aircraft and other industrial entities offering so called - Internet of Things services. Yet some of those same services are weather sensitive, requiring the meteorological and hydrological warnings sent via 1675 – 1680 MHz and adjacent bands for their operational needs. Helicopters who require precise location data for short notice flights from hospital helipads or from off-shore facilities supporting energy exploration require up to date weather information. By Ligado offering commercial services in this particular spectrum band, instead of in different spectrum, the customers may be more impacted by weather or the potential lack of timely weather or water warnings "in exchange" for their new commercial services.

and warnings. The nation is at risk of diminishing quality weather forecasts if NOAAPort, transmitted via a commercial system, faces any risk of interference.

Many federal users of weather and water data, including NOAA's National Weather Service (NWS), the Federal Aviation Administration (FAA), military branches such as the Navy and other federal agencies, receive their information via receiving systems in C-band (3.7 – 4.2 GHz). About 167 ground locations, within NOAA and the FAA, receive data via the Satellite Broadcast Network (also known as NOAAPort).

Scientific workstations used by many federal users, such as weather forecasters and hydrologists, receive much of their source data from NOAA satellites, terrestrial sensors and radars via NOAAPort in 3.7 – 4.2 GHz spectrum. These workstations, called the Advanced Weather Interactive Processing System (AWIPS), support forecast meteorologists and hydrologists at 167 locations within and outside the continental U.S., including Alaska, Hawaii, Puerto Rico and Guam.

Similarly, non-federal use of NOAAPort is widespread, with aviation users, academia and private sector meteorological users operating their own receive-only non-licensed NOAAPort systems. In addition, some media outlets, especially television stations, receive NOAAPort information directly as well to support their local forecasting capabilities, especially in times of severe weather.

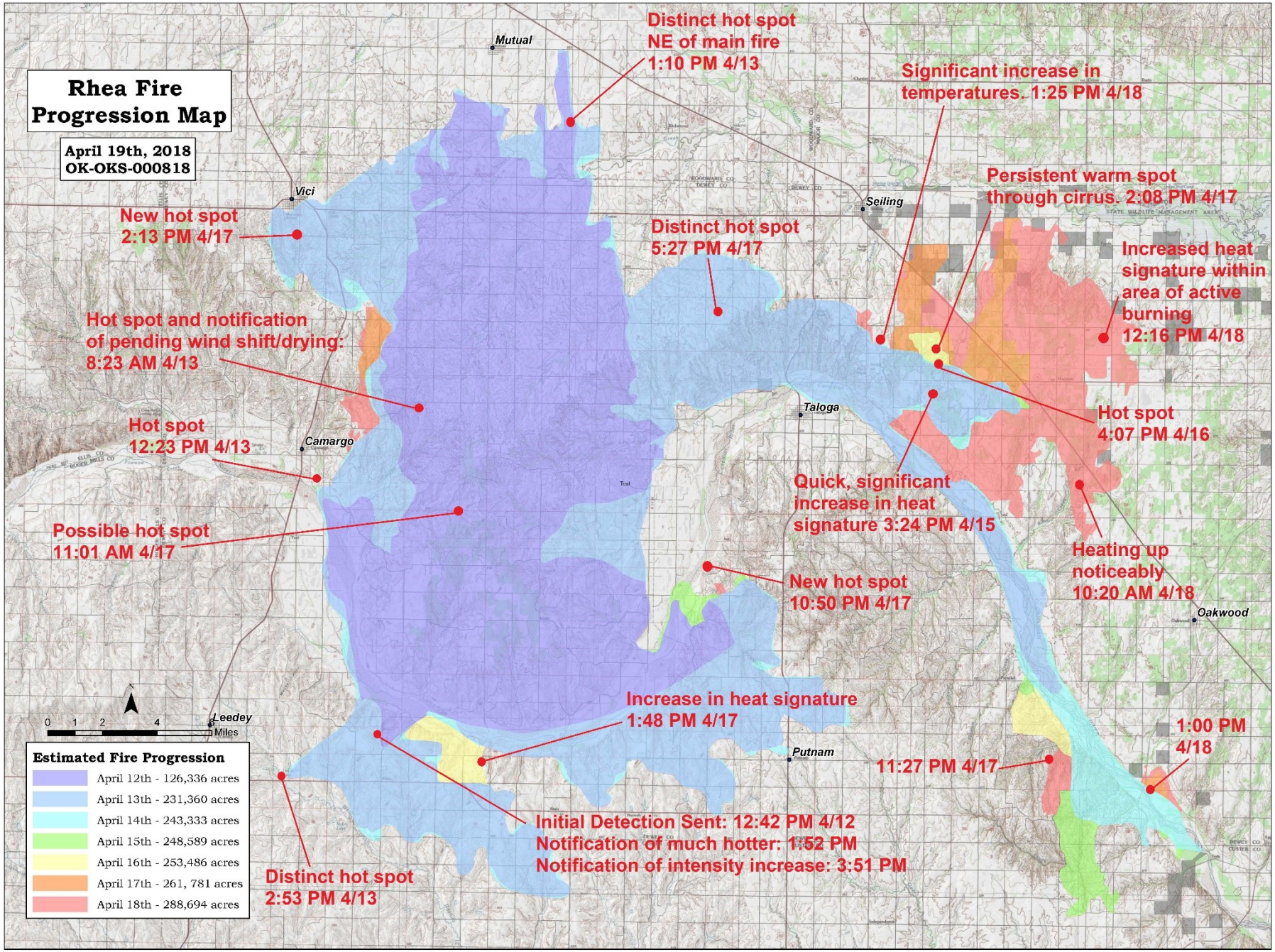
How is the use of NOAAPort distinct and important in comparison to other spectrum-reliant technologies used by the meteorological and hydrological community?

The satellite data transmitted via NOAAPort into the AWIPS system consists of only some of the available imagery from NOAA's environmental satellites. The GOES satellite information entering AWIPS from NOAAPort has been processed into sectorized blocks for specific regions and focuses on those data types that are most important to the individual NWS Weather Forecast Offices (WFOs) and Regional Offices to complete their core work to generate watches and warnings. Some key products included are generated from cloud and moisture imagery, but other selected satellite products are included as well.

In contrast, when there is a need for a more comprehensive set of information coming from NOAA's Geostationary Operational Environmental Satellites (GOES), such breadth of information (including all spectral bands and regions of coverage from the system) is only available in real-time from GOES Re-Broadcast service (GRB) (which operates between 1675-1695 MHz). This service is extremely important for federal users who require complete data sets, and/or low data latency/high data availability, such as the work of the National Hurricane Center, the Storm Prediction Center, the Weather Prediction Center, the Space Weather Prediction Center and the Aviation Weather Center, all of which have their own GRB downlink stations. Also, in the most severe forecasting situations, when minutes and seconds matter, the data transmitted through the GRB system is available more quickly than the more processed information via NOAAPort and GRB can be delivered directly to the end user location without the use of "last mile" terrestrial connectivity.

Overall for both federal and non-federal users, NOAAPort serves as an important complement to land-based communications to ensure high availability of weather data transfer from numerous sources, crucial for success of the public, private and academic partners in the weather community in their shared public service mission.

Submitted by the briefing participants from industry, professional organizations, and academic partners of the hydrometeorological community.


Rhea Fire
Progression Map
April 19th, 2018
OK-OKS-000818
Distinct hot spot
NE of main fire
1:10 PM 4/13
Significant increase in
temperatures. 1:25 PM 4/18
Persistent warm spot
through cirrus. 2:08 PM 4/17
New hot spot
2:13 PM 4/17
Distinct hot spot
5:27 PM 4/17
Increased heat
signature within
area of active
burning
12:16 PM 4/18
Hot spot and notification
of pending wind shift/drying:
8:23 AM 4/13
Hot spot
12:23 PM 4/13
Hot spot
4:07 PM 4/16
Quick, significant
increase in heat
signature 3:24 PM 4/15
Possible hot spot
11:01 AM 4/17
Heating up
noticeably
10:20 AM 4/18
New hot spot
10:50 PM 4/17
Increase in heat signature
1:48 PM 4/17
1:00 PM
4/18
11:27 PM 4/17
Initial Detection Sent: 12:42 PM 4/12
Notification of much hotter: 1:52 PM
Notification of intensity increase: 3:51 PM
Distinct hot spot
2:53 PM 4/13
Mutual
Vici
Seiling
Taloga
Camargo
Oakwood
Putnam
Leedey
0 1 2 4
Miles
Estimated Fire Progression
April 12th - 126,336 acres
April 13th - 231,360 acres
April 14th - 243,333 acres
April 15th - 248,589 acres
April 16th - 253,486 acres
April 17th - 261, 781 acres
April 18th - 288,694 acres